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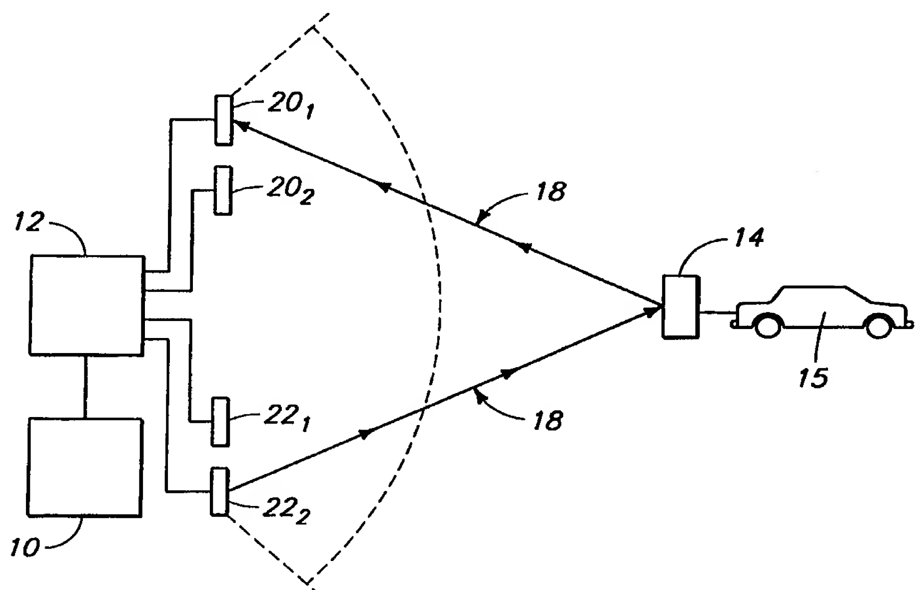
(54) Title: A METHOD AND APPARATUS FOR COMMUNICATING WITH A BACKSCATTER REMOTE INTELLIGENT COMMUNICATIONS DEVICE

(57) Abstract

A remote intelligent communications device includes a primary RF communications port and an alternative modem communications port. The remote intelligent communications device receives configuration data for configuring the alternative modem communications port. The remote intelligent communications device obtains information data concerning a select attribute of an associated object. The information data is stored within internal memory of the remote intelligent communications device. Thereafter, the stored information data is retrieved, per one embodiment via the alternative modem port, from the remote intelligent communications device and analyzed for drawing conclusions regarding the select attribute of the associated object. Preferably, the remote intelligent communications device also includes a navigation (e.g. GPS) receiver that obtains navigation data, which navigation data is also stored within the internal memory of the remote intelligent communications device. By storing this navigation data together with the information data, once the stored data is retrieved from the remote intelligent communications device, the information data and navigation data can be analyzed for correlating the select attribute of the associated object with respective geographic position in accordance with the analyzed information and navigation data. In one exemplary application, the specific attribute is an open/close condition of a door of a cargo bay, monitored by an appropriate transducer disposed functionally proximate thereto.



A METHOD AND APPARATUS FOR COMMUNICATING WITH A BACKSCATTER REMOTE INTELLIGENT COMMUNICATIONS DEVICE

Technical Field

The present invention relates generally to remote intelligent communications, and, more particularly, relates to an interrogator and associated method for communicating with a backscatter remote intelligent communications device.

Background Art

Radio frequency (RF) identification devices are known for identifying or tracking select animate, or inanimate, objects in accordance with unique identification codes. As a part of a remote intelligent communications system, an interrogator interrogates RF identification devices, by way of an RF communications medium, and determines the identity and presence of the particular identified devices.

The integrity of the remote monitoring system depends largely upon the quality of the RF communications link between the interrogator and the RF identification devices. Various factors can influence this link, including: power levels of the signals propagated from the respective interrogator and identification devices, presence or absence of RF resonant obstacles (e.g., a multi-path cancellation hazard) between the interrogator and identification devices, distance between the interrogator and the identification devices, in addition to a presence or absence of interfering RF signals within a communication channel of the RF communications link. Accordingly, it would be advantageous to provide an interrogator and system capable of providing continued communication capabilities when one, or more, of the above factors might otherwise degrade the integrity of a given communication channel.

Additionally, security or other spectral distribution restrictions may require that the interrogator and/or remote intelligent communications (RIC) device employ a frequency spreading technique, e.g., frequency hopping, wherein the electromagnetic spectral energy of the radio frequency (RF)

communications is distributed over a plurality of frequency spectra. Typically, the interrogator sends out a message to a RIC device; whereupon, the RIC device provides a reply. One, or alternatively both, of the forward message and the return message may require such frequency spreading. When employing known frequency hopping communications, the transmitting and receiving units typically are both preprogrammed with a common, predetermined, frequency hopping sequence so that the receiving unit is able to change its receiving band and track, in synchronization with, carrier frequency changes of the transmitting unit. This has been of particular importance for communication systems employing an active RF responding RIC device.

Summary of the Invention

The present invention provides a new interrogator, RIC system, and method for communicating with a remote intelligent communications device. In a particular embodiment, an interrogator sends out a frequency hopping signal to a responder. At the same time, the interrogator receives a signal returned from the responder and demodulates the returned signal using a demodulating local oscillator signal coherently related to the interrogator's output signal.

In accordance with one embodiment of the present invention, an interrogator (or transceiver) includes a transmitter and receiver for communication with a responder. The transmitter transmits an output signal that is coherently related to a signal produced by a signal generator of distributed spectra - differing frequency over time. The receiver receives an RF input signal and includes a demodulator for demodulating the received RF input signal. The demodulator demodulates the received RF input signal using a demodulating local oscillator signal of frequency and phase coherently related to that of the generator's signal.

In accordance with one aspect of this embodiment of the present invention, the signal generator includes a phase lock circuit having programmable dividers as a part of its synthesis loop. The phase lock circuit produces an output signal in phase lock relationship to a reference signal.

The phase lock circuit establishes a frequency for the output signal that is harmonically/subharmonically related to the reference signal by way a programmable frequency ratio, e.g., N:M wherein N and M represent positive integers. In accordance with a further aspect of this particular embodiment, a random number generator provides a random distribution, over a particular time interval, of frequency ratio data (within a predetermined range of valid ratio data) for programming the frequency ratio of the phase lock circuit. The random generator thereby effects a random frequency hopping sequence, for the transmitter's output signal, that is related to its random number sequence.

Preferably, a preprogrammed register stack provides a plurality of sequentially addressable frequency data that is selectively coupled to control the frequency of the signal generator. An address pointer addresses the register stack to forward respectively addressed frequency data to the signal generator. By way of the pointer's address sequence and the arrangement of frequency data in the register stack, the frequency of the generator's output signal follows a random frequency hopping sequence.

In the preferred embodiment of the present invention, the receiver's demodulator within the interrogator includes a quadrature down-converter that mixes the received input signal, in a first mixer, with an in-phase (I) representation of the local oscillator signal and, in a second mixer, with a quadrature-phase (Q) representation of the local oscillator, providing respective in-phase (I) and quadrature-phase (Q) base band signals.

In addition, the receiver of the preferred embodiment interrogator further comprises a high dynamic range amplifier that amplifies the received input signal before sending it to the demodulator. The relative placements of the interrogator's transmitting and receiving antenna(s), taken together with the transmitting power of the transmitter, result in a residual coupling of the transmitter's output signal into the receiver. The gain of the high dynamic range amplifier is set to improve the signal-to-noise ratio of a reply signal, while, at the same time, avoiding saturation of itself and of the demodulator upon amplifying the residually coupled portion of the transmitter's output signal.

In accordance with another embodiment of the present invention, an interrogator, similar to those describe above, is employed within a remote intelligent communications system to communicate with a backscatter responder. The responder has an antenna structure of programmable reflectivity characteristics. Upon receiving a signal from the interrogator, the responder modulates its antenna reflectivity characteristics in accordance with a desired reply message, thereby reflecting, over a particular time interval, differing amounts of the interrogator's signal back toward the interrogator. Preferably, the reply message comprises a subcarrier signal with message data modulated thereon in accordance with a particular modulation format. Alternatively, the reply message comprises raw data for modulating the antenna directly via the message data.

In a preferred method of operating any of the above interrogators, or communication systems, the demodulated base band signal at the interrogator is examined for information content. If the demodulated base band signal does not include any message information over a predetermined time interval, then the interrogator's signal generator is triggered to advance its frequency to the next frequency of its frequency hopping sequence.

Brief Description of the Drawings

Figure 1 is a simplified block diagram of a remote communications system for communicating selectively with particular remote intelligent communication devices;

Figure 2 is a block diagram illustrating forward and return communication links with a remote intelligent communications device as employed within a given remote communications system;

Figure 3 is a simplified, partial block diagram of an interrogator of the present invention;

Figure 4 is a more detailed block diagram of the front end of a receiver within an interrogator of the present invention;

Figure 5 is block diagram of an exemplary base band demodulator for an interrogator's receiver; and

Figures 6-7 are block diagrams of exemplary signal generators for driving the transmitter and receiver of the interrogator.

Best Modes for Carrying Out the Invention and Disclosure of Invention

In a remote intelligent communication system, with reference to Figs. 1 and 2, a host computer 10 communicates across a given communication medium 18 with a select remote intelligent communications device 14_1 of a plurality of remote intelligent communication devices 14_0, 14_1, 14_2. Typically, an interrogator 12 is employed intermediate host computer 10 and communications medium 18 for appropriately coupling host computer 10 to the medium 18. Preferably, host computer 10 has a library of commands 11 available for configuring and operating interrogator 12, remote intelligent communications device 14, and itself.

In an exemplary application, host computer 10, per appropriate programming, retrieves appropriate commands from within its library of commands 11 and sends associated command data to interrogator 12 by way of a digital interfacing link 16. Preferably, digital interfacing link 16 is an enhanced parallel port (EPP) digital interface. The command forwarded from host 10 to interrogator 12 can be a command for configuring the interrogator, or a command for operating interrogator 12, or a command for configuring or operating remote intelligent communications device 14.

Upon receiving the command, interrogator 12 configures itself appropriately in accordance with the command instructions and/or forwards appropriate data along a forward RF communications link 18_f (as shown in Fig. 2) to remote intelligent communications device 14. Depending upon the type of command, remote intelligent communications device 14 may respond with an appropriate return signal 18_r. If such a reply is received, interrogator 12 extracts digital data from the RF reply signal and forwards the reply message to host computer 10 for further analysis.

In a preferred embodiment of the present invention, host computer 10 is a computer compatible with Microsoft DOS™ and has a processor of performance equal to or greater than an 80486™ processor. Preferably, host computer 10 has an enhanced parallel port (EPP) for providing a digital

interface 16 with interrogator 12. A library of commands for operating interrogator 12 and remote intelligent communication devices 14, are available in a software tool "Micron RFID Library (MRL)" available from Micron Communications, Inc. of Boise, Idaho. Appendix A, attached hereto, includes a copy of "Micron RFID Systems Developer's Guide", version 3.1, May 9, 1996, of Micron Communications, Inc. of Boise, Idaho, which provides a user's guide for identifying software commands available within the MRL software tools, and how to employ such commands for configuring and operating a remote intelligent communications system.

In one embodiment of the present invention, remote intelligent communications device 14 comprises an Ambit™ remote intelligent communications device, available from Micron Communications Inc. of Boise, Idaho. In an alternative embodiment of the present invention, device 14 comprises a Microstamp™ remote intelligent communications device, also available from Micron Communications, Inc. of Boise, Idaho. In most instances, the commands for operating these two devices are essentially the same; differences therebetween are described in the "Micron RFID Systems Developer's Guide" of appendix A.

With reference to Figs. 1-4, interrogator 12 receives digital data by way of a digital interfacing port (e.g., EPP). Certain commands of the "Micron RFID Library" are associated with configuring interrogator 12. For example, interrogator 12 may receive a command for structuring appropriate transmit and receive antenna structures. A receive antenna structure, in one embodiment of the present invention, includes two separate antennas 20_1 and 20_2 selectively configurable for receiving an RF signal. Likewise, transmitting antennas structures 22_1 and 22_2 are selectively configurable for enabling transmission of RF signals away from interrogator 12. Diversity switches 32, 38 of the transmit and receiver communication paths respectively are configurable in accordance with configuration data received by digital controller 27 and arranged into diversity data arranger 36 and associated register queue 34. The diversity switches configure the respective antenna structures of the receiver and transmitter communication links of interrogator 12. U. S. Patent Application Serial No. 08/________, filed 12/19/96,

(Attorney Docket No. MI40-057), of Cliff Wood, entitled "Communication System Including Diversity Antenna Queuing", assigned to the assignee of the present invention, hereby incorporated by reference in its entirety, provides additional information regarding the diversity operation of the transmit and receive antenna structures.

As part of a forward transmission chain, interrogator 12 (with reference to Fig. 3) includes power divider 26 that receives a signal from frequency synthesizer 24, referred to hereinafter as a signal generator, and forwards part of the generator's signal to an AM modulator 28. AM modulator 28, of know type, amplitude modulates the carrier signal (received from signal generator 24) with appropriate forward or command data 29 as provided by digital controller 27 (Figs. 3-4). Power amplifier 30 receives the modulated carrier signal from modulator 28 and amplifies the signal before sending it to transmitter antenna structure 22 as selected in accordance with diversity switch 32. In one exemplary embodiment, signal generator 24 provides a carrier frequency in the vicinity of 900 MHZ, with a 5MHz tuning range. In an alternative exemplary embodiment, the signal generator provides a carrier frequency in the vicinity of 2.4 GHz with a 30 MHZ tuning range. Although described with reference to particular exemplary frequencies and tuning ranges, it will be understood that scope of the present invention similarly encompasses embodiments employing signal generators of different frequencies and tuning ranges, yet providing similar functionality. Description and operation of signal generator 24 is provided more fully hereinafter.

In accordance with a particular embodiment of the present invention, a backscatter remote intelligent communications device 14 receives the signal, at least a portion thereof, as transmitted by interrogator 12. In particular embodiments, remote intelligent communications device 14 comprises a Microstamp™ remote intelligent communications device, or an Ambit™ remote intelligent communications device, both of which are available from Micron Communications, Inc. of Boise, Idaho. Details, some of which are provided here below, regarding a particular backscatter remote intelligent communications device 14 can be found in U.S. Patent Application

08/705,043, filed 8/29/1996, entitled "Radio Frequency Data Communications Device", (96-0327.00), assigned to the assignee of the present invention, and hereby incorporate by reference in its entirety.

For certain forward messages sent, interrogator 12 expects a reply message from the RIC device 14. After the interrogator has transmitted the forward message, and is expecting a response, the interrogator switches to a CW mode (continuous wave mode), wherein the transmitter send out a CW signal absent AM modulation. The generator's carrier signal, e.g., 2.4 GHz, is passed through modulator 28, to power amplifier 30 and on to the transmitting antennas 22 for transmission without any modulation thereon. To provide a reply, backscatter remote intelligent communications (RIC) device 14 utilizes the interrogator's transmitted output signal itself as a carrier signal upon which to modulate its reply signal.

In a particular backscatter embodiment of the present invention, antenna of the RIC device 14 includes a pair of conductive lines (not shown) coupled as an input section to a dipole or loop antenna. To enable backscatter operation (described more fully in U.S. Patent Application 08/705,043, entitled "Radio Frequency Data Communications Device", 96-0327, incorporated hereinbefore by reference) a switching element (not shown) is coupled between the forward and return conductive lines of the antenna structure proximate the antenna's interface to the RIC device 14. When the selective switch is closed, the reflectivity/impedance characteristics of the associated antenna will be different in comparison to its reflectivity/impedance characteristics when the switch is open. Preferably, when the selective switch is open, the antenna provides a non-resonant, matched termination impedance for minimizing reflection of RF signals (at a given frequency) incident upon RIC device 14. On the other hand, when the switching element is closed, preferably the device provides a short, shorting the forward and return conductive lines. Accordingly, RF signals received at the RF input port are reflected rather than terminated by the remote intelligent communications device 14. By modulating the reflective characteristics of the antenna structure, via the open/short characteristics of the selective switch, a reflective RF signal can be selectively provided. The carrier frequency

of the reflected RF signal will correspond to the carrier frequency of the incident RF signal, while the amplitude modulation of the reflected RF signal is established in accordance with the opening and closing of the selective switch.

Preferably, the selective switch (not shown) is a pin diode. Alternatively, the switching device is a Schottky diode, a bipolar transistor, or a FET transistor, wherein the respective diode or transistor is functionally modulated in accordance with data to be sent out from RIC device 14, i.e. the reply data.

With reference to Figs. 3-4, amplifier 40 receives an RF input signal from the receiver antenna structure 20 (via diversity switch 38) and forwards an amplified representation of the received RF signal to down converter 42 by way of bandpass filter 48 and power splitter 50 as shown in Fig. 4. In accordance with the present invention, Down converter 42 receives a local Oscillator (LO) signal from an internal frequency synthesizer 26 via power divider 28. The LO signal mixes with the received RF input signal for providing an intermediate frequency (IF) output (e.g., I and Q outputs for full quadrature demodulation) which is forwarded to demodulator 44. Demodulator 44 demodulates the IF signal received from down converter 42 and recovers data therefrom in accordance with the modulation present on the IF Signal. Typically, digital controller 24 receives the recovered data and forwards it to host computer 10 by way of digital interface 16.

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In the remote intelligent communications system depicted in Fig. 2, remote intelligent communications device 14 is associated with an automobile 15. However, in alternative applications, remote intelligent communications device 14 is associated with other animate or inanimate objects, including, but not limited to, luggage, a shipment package, an animal, a manufacturing assembly, a railway car, a water vessel, etc.

In the remote intelligent communications systems as described with reference to Figs. 1 and 2, remote intelligent communications device 14 generally uses a line-of-sight RF path with reference to interrogator 12 in order to maintain integrity of the associated RF communications link 18

therebetween. Should obstacles or interference be encountered along the RF communication path, the communication link may be lost. In addition, transmission power limitations of interrogator 12 and remote intelligent communications device 14 can likewise affect the integrity of, and distal range available for, the RF communications link.

In accordance with one embodiment of the present invention, an alternative modem link is provided between host computer 10 and remote intelligent communications device 14, as shown in Fig. 4. A modem 52 is coupled to host 10 via an appropriate modem interface 50. Preferably, interface 50 comprises an RS-232 data interface. Likewise, remote communications device 14 is coupled to another modem device 54 by way of an appropriate digital interface 56, preferably, an RS-232 compatible interface. Modem devices 52, 54 are coupled appropriately therebetween by way of an appropriate modem interfacing channel 58, preferably establishing a "transparent" alternative interfacing solution between host 10 and remote intelligent communications device 14. The alternative modem interface is alternative to the normal RF communications link 18.

In accordance with one aspect of this particular embodiment of the present invention, interfacing medium 58 between modem devices 52 and 54 comprises a wireless intercommunications medium, such as an alternative RF channel, an optical medium, or an acoustic medium. Modem devices 52, 54 comprise appropriate wireless modem devices for communicating therebetween via the associated wireless medium In accordance with a second aspect, the interfacing medium 58 comprises a cellular network, and modem devices 52 and 54 are cellular modem devices for interfacing to a cellular network. Typically, the cellular modem devices and the cellular network employ analog cellular modulation technology for the communications link. Alternatively, and preferably, the cellular modem devices and cellular network employ a cellular digital packet technology that is more secure than an analog cellular communications link. In a third aspect in this embodiment of the present invention, modem devices 52 and 54 are satellite modem devices for enabling communications therebetween by way of a satellite link

58. Examples of the above modem devices are available from Motorola, Inc. and other modem manufacturers.

The above modem devices enable alternative communications between host computer 10 and remote intelligent communications device 14 in accordance with the respective wireless, cellular, and satellite links. Thus, should a remote intelligent communications device 14 be carried beyond its normal operating range associated with RF communications link 18, or should undue RF interference be encountered within the normal RF communications link 18; the host computer can attain an alternative communicate link with remote intelligent communications device 14 by way of the alternative modem devices 52, 54. Preferably, modem devices 52, 54 and associated digital interfacing, provide a transparent RS-232 interfacing solution between host computer 10 and remote intelligent communications device 14.

With reference to Figs. 5 and 6, normal RF communications with remote intelligent communications device 14 is established by way of an RF port 64. In one embodiment of the present invention, RF port 64 comprises a single antenna structure. In an alternative embodiment, two separate antennas are used, e.g., one for receiving and a second for transmission. Typically, receiver 66 includes appropriate down conversion, filtering, amplification, and detection circuitry. Receiver 66 is coupled to the RF port 64 for receiving an input RF signal. Receiver 66 forwards an appropriately received RF input signal to a clock and data recovery circuit 68. Clock and data recovery circuitry 68 receives an output signal as output from receiver 66 and recovers appropriate data therefrom. Additionally, clock and data recovery circuitry 68 recovers a clock signal having a frequency related to, and edges in synchronization with, the recovered data. In one embodiment of the present invention, a recovered clock 76 is sent to output frequency modulator 70. Output modulator 70 provides a carrier signal of a frequency related to the frequency of the recovered clock and modulates the carrier signal in accordance with desired data for an appropriate output transmission.

Data recovered by the clock and data recovery circuitry 68 is forwarded as input data 74 to microcontroller 60. Input data 74 may

comprise command data, in addition to associated configuration data or other forms of information. Microcontroller 60 interprets the input data appropriately for controlling operation of remote intelligent communications device 14. Such control may include configuration of desired digital ports 84, configuration of desired analog ports 86, partialing or allocation of memory 62, configuration of appropriate antenna structures at RF port 64, selection of desired input/output frequency channels, time duration and operation of wake up circuitry 86, and/or charging of, or distribution of current from, battery 83.

In addition, microcontroller 60 controls operation of alternative modem port 80 for selectively interfacing with the alternative modem device 54. Preferably, the interface between microcontroller 60 and modem 54 is an RS-232 digital interface. In such conditions, microcontroller 60 enables the alternative modem port for external communications, and configures (104 of Fig. 8) the alternative data modem for an appropriate baud rate, e.g. 2400, 4800, or 9600 bits per second.

One method of enabling and configuring modem 54 involves sending an appropriate command and accompanying configuration data to the remote intelligent communications device 14 by way of the primary RF interface 18. microcontroller 60 interprets the command appropriately and enables the alternative modem port 80 by forwarding appropriate configuration data to an associated control register (not shown) within the remote intelligent communications device 14. Additionally, microcontroller 60 forwards the appropriate configuration data, as might be associated with the desired baud rate and appropriate communications protocol, to modem 54 for enabling proper communications with host 10.

Alternatively, remote intelligent communications device 14 may have select pins which can be hard-wired to an appropriate voltage potential, for example, ground or V_{cc}, such that whenever the remote intelligent communications device 14 powers-up, microcontroller 60 senses the fixed hard wired pins and configures itself appropriately, enabling the modem port 60 and appropriately configuring modem device 54 in accordance with the condition of the hard-wired pins. Another method of providing a power up

configuration sequence comprises storing appropriate command and configuration data in nonvolatile memory within the remote intelligent communications device 14. At power-up, the command data and appropriate configuration data are retrieved from the nonvolatile memory and executed accordingly by microcontroller 60 during a power-up configuration sequence.

In the above embodiment, the interface between the remote intelligent communications device 14 and modem device 54 was described as an RS-232 interface. In an alternative embodiment, the interface between modem 54 and remote intelligent device 14 comprises a serial data link and a synchronization clock line for sending data therebetween in synchronization with an appropriate clock signal. This alternative interfacing topology is disclosed more fully in U.S. Patent Application_________, entitled "Radio Frequency Data Communications Device", filed 5/13/96, (96-0327.00), incorporated hereinbefore.

In one exemplary embodiment of remote intelligent communications device 14, wake-up circuitry 82 senses when an appropriate RF input signal is received by receiver 66 and activates other portions of remote intelligent communications device 14 upon receiving a valid RF input signal and upon determining a valid interrogation protocol, compatible with the particular remote intelligent communications device 14. In an alternative embodiment of a remote intelligent communications device, wake-up circuitry 82 includes a self-timer that periodically forces an inquiry for determining the presence of an interrogation signal. When the self-timer times out at the end of a sleep mode, the wake-up circuitry 82 enables receiver 66 and clock and data recovery circuitry 68. Once these portions have been enabled, a further determination can be made as to whether or not a valid input signal is received. Upon determining a valid interrogation signal (per an appropriate interrogation protocol), the wake-up circuitry enables additional portions of the remote intelligent communications device 14 for full operation.

Battery 83 provides power to various elements of the remote intelligent communications device and is enabled appropriately by wake-up circuitry 82. During a sleep mode of operation, wake-up circuitry minimizes the amount of current drawn from battery 83. During alternative operating modes,

wake-up circuitry 82 enables battery 83 to provide appropriated current flow to portions of remote intelligent communications device 14 as needed.

Additional information regarding wake-up circuitry 82 and associated protocol is available in the above incorporated U.S. Patent Application entitled "Radio Frequency Data Communications Device". Additional disclosure regarding sleep mode operation of a remote intelligent communications device is provided by U.S. Patent Application Number 08/424,827, entitled "Wake up Device for a Communication System", filed April 19, 1995; which is a continuation of U.S. Patent Application Number 08/092,147, filed August 15, 1993, which patent applications are assigned to the assignee of the present invention, and are hereby incorporated by reference in their entirety.

Additional information regarding a communication protocol between an interrogator 12 and a remote intelligent communications device 14 is available in some of the above incorporated U.S. Patent Applications, in addition to U.S. Patent Number 5,500,650, entitled "Data Communication Method Using Identification Protocol", issued March 19, 1996, filed December 15, 1992, (92-0165.01), and U.S. Patent Number 5,479,416, entitled "Apparatus and Method for Error Detection and Correction in a Radio Frequency Identification Device", issued December 26, 1995, filed September 30, 1993, (92-0237.00), which U.S. Patents are assigned to the assignee of the present invention and incorporated herein by reference in there entirety.

In a preferred exemplary embodiment of the present invention, with reference to Figs. 5 - 8, remote intelligent communications device 14 has a first digital interfacing port 84_1 tied to a navigation receiver, e.g., a global positioning systems (GPS) receiver 88. GPS receiver 88 receives select GPS satellite information, by way of an appropriately tuned GPS antenna 89. An additional digital IO port 84_2 is selectively coupled to other monitoring circuitry 94, such as: a "trip master"™ of a delivery truck as is available from Rockwell International Corp., a continuity tester for monitoring a door of a delivery truck, or an analog-to-digital device that provides digital information to the remote intelligent communications device 14 representative of an analog measurement signal being sampled thereby. Analog IO port 86_1

is selectively coupled to a transducer 90 (or alternatively, an accelerometer 92) for receiving an analog measurement signal in accordance with an associated continuity, pressure, magnetic field, temperature, or acceleration as measured by the respective transducer. Microcontroller 60 controls the configuration of the digital and analog IO ports 84, 86 respectively, in accordance with appropriate command and configuration data.

Preferably, remote intelligent communications device 14 also includes a comparator 96, and/or an analog-to-digital converter 98, which comparator and converter are selectively enabled by the controller in accordance with associated command and configuration data. In a select configuration, comparator 96 receives the analog signal of analog port 86, and compares this analog signal against a predetermined reference voltage $V_{ref.}$ Comparator 96 then triggers a flag (or an alarm) to microcontroller 60; signaling that the voltage received at analog port 86_1 is greater (or less) than the voltage V_{ref}. In an alternative select configuration, the analog signal received at analog port 86_1 is coupled to the input of analog-to-digital converter 98. The analog-to-digital converter receives the analog input signal and converts the signal into a digital signal, i.e. measurement data representative of the analog voltage. The digital signal is forwarded to microcontroller 60 or an appropriate digital bus.

In an exemplary application of one embodiment of the present invention, with reference to Fig. 7, a remote intelligent communications device 14 is employed for monitoring an open/close condition of a door 102 of a cargo bay 100 of, for example, a delivery truck. A transducer 90 is configured with cargo bay 100, proximate door 102, for determining when door 102 is opened or closed. For example, transducer 90 preferably comprises a magnetic transducer for sensing magnetic characteristics as may be associated with the opening/closing of door 102. Transducer 90 produces an analog signal representative of the open/close condition, that is forwarded to analog port 86_1 of remote intelligent communications device 14. Although transducer 90 is described as a magnetic transducer, transducer 90 in an alternative exemplary embodiment is a continuity monitor, as employed and disclosed in U.S. Patent Number 5,406,263, entitled "Anti Theft Method for

Detecting the Unauthorized Opening of Containers and Baggage", issued April 11, 1995, assigned to the assignee of the present invention, and hereby incorporated by reference.

Remote intelligent communications device 14 is configured appropriately (106 of Fig. 8) to monitor the input analog signal, perhaps via comparator 96, to determine when door 102 has been opened. Upon determining a door opening microcontroller 60 records the condition appropriately. In accordance with one aspect of this embodiment of the present invention, comparator sends an interrupt to microcontroller 60 upon sensing an excessive signal at the analog part 86_1. Alternatively, microcontroller 60 examines analog port 86_1 periodically and checks the condition or status of door 102, as measured by transducer 90.

In addition to monitoring the condition of door 102, remote intelligent communications device 14 can record (106 of Fig. 8), per an appropriate configuration, information as received from a navigation receiver, such as GPS receiver 88, selectively coupled to digital port 84_1. GPS receiver 88 receives GPS information by way of its GPS interconnect, e.g. antenna 89. Remote intelligent communications device 14 receives the GPS information and logs navigation data thereof into memory 62. In this fashion, coordinate information regarding a position of a delivery truck, i.e. cargo bay 100, can be associated with respective openings and/or closings of door 102. Subsequently, the stored measurement data as obtained by transducer 90, and stored coordinate data as obtained by navigation receiver 88, are retrieved from memory 62 and read (108 of Fig. 8) by host 10 via RF interconnect 18, or by way of an alternative modem communications channel as disclosed hereinbefore.

As data is read from the remote intelligent communications device 14, it is preferably accumulated (110 of Fig. 8) within host computer 10 for subsequent analysis. To assist this analysis, the accumulated measurement and coordinate data is imported into a given data analysis software tool. The data analysis tool provided can be a known spreadsheet analysis tool, such as, for examples, Excel ™, Lotus™, Microsoft Access™, or similar available data analysis software tool. Alternatively, a custom data analysis

program may be developed as suited for the particular remote monitoring application. Appropriate macros are preferably developed, in a known fashion, for deriving meaningful conclusions or reports regarding the respective parameters retrieved from the remote interrogation communications device 14. In reporting (112 of Fig. 8) the monitored characteristics, a graph or chart is preferably compiled in accordance with the derived conclusions and portrayed appropriately on a given display (or print medium) using known audio and/or visual multi-media tools.

In a preferred exemplary method of the present invention, a particular measurement phenomenon, as monitored by a given remote intelligent communications device 14, is correlated with associated geographic position(s), time/date information, temperature, and/or other selective measurement event(s), in order to provide additional understanding of the particular measurement phenomenon. For example, when the particular measurement phenomenon concerns the opening or closing of a door, in can be correlated with an associated geographic position and/or time, for aiding determination of acceptable door opening/closing as opposed to an unacceptable door opening or closing. Furthermore, a temperature profile may be correlated with respective door openings and closings together with associated time intervals therebetween for determining excessive refrigeration or heating demands for temperature recovery. Thereafter, corrective actions may be taken as desired based upon the conclusions provided by the data analysis.

In the particular exemplary configuration disclosed above, transducer 90 is disclosed as a transducer external to remote intelligent communications device 14. In U.S. Patent Application "Radio Frequency Data Communications Device" (96-0327.00), incorporated hereinbefore, a remote intelligent communications device has an internal magnetic sensor associated therewith. The internal sensor can selectively monitor particular magnetic properties, as might be associated with door 102.

In further aspects of the above exemplary application, remote intelligent communications device also includes: a temperature transducer for simultaneously monitoring temperature, an accelerometer for monitoring

shipping stability (shock), or interfacing circuitry for obtaining additional information from a “trip master” of an associated carrier vehicle 100. These various alternative input devices were described more fully hereinbefore with reference to Fig. 6.

It should be readily understood that the embodiments described and illustrated herein, are illustrated only, and are not to be considered as limitations upon the scope of the present invention. Other variations and modifications may be made in accordance of the spirit and scope of the present invention.

CLAIMS

1. A method of remotely monitoring a select aspect of an object comprising:

(a) providing a remote intelligent communications device having:

internal memory for storing data,

a control register for retaining configuration data for configuring an architecture of the remote intelligent communications device in accordance with the configuration data, and

a plurality of ports selectively enabled per configuration data of said control register, one of said ports being a modem communications port;

(b) storing configuration data in said control register of said remote intelligent communications device for enabling said modem port;

(c) associating said remote intelligent communications device with an object;

(d) storing information data concerning a select aspect of said object within said memory; and

(e) forwarding a command to said remote intelligent communications device for enabling retrieval of the information data concerning said object via said modem port.

2. A method according to claim 1, further comprising:

(f) retrieving the information data from said remote intelligent communications device via said modem communications port;

(g) accumulating the information data as retrieved from said remote intelligent communications device; and

(h) driving a reporting means for reporting the select aspect of said object in accordance with the accumulated information data.

3. A method according to claim 2, further comprising repeating a plurality of times said steps (d) of storing, (e) of forwarding, and (f) of retrieving.

4. A method according to claim 2, further comprising;

coupling said modem communications port to a cellular telephone network;

wherein said steps (e) of forwarding and (f) of retrieving, transfer associated data via said cellular network.

5. A method according to claim 1, wherein said modem port comprises a digital data interfacing port and a modem device, and said step (e) of forwarding comprises:

(1) receiving command data representative of said command at said modem device;

(2) structuring the received command data into an appropriate digital format compatible with said digital data interfacing port; and

(3) passing the structured command data to said remote intelligent communications device via said digital data interfacing port.

6. A method according to claim 5, wherein said modem device comprises a wireless modem device and said step (e) of forwarding further comprises:

(4) propagating a command signal carrying said command data to said wireless modem via a wireless communications medium.

7. A method according to claim 6, wherein said step (e) (4) of propagating comprises propagating one of a RF command signal, an acoustic command signal, and an optical command signal to said wireless modem device.

8. A method according to claim 5, wherein said modem device comprises a cellular phone modem device and said step (e) of forwarding comprises:

(4) propagating a command signal carrying said command data to said cellular phone modem device via a cellular phone network.

9. A method according to claim 5, wherein said modem device comprises a satellite intercommunication modem device and step (e) of forwarding comprises:

(4) propagating a command signal carrying said command data to said satellite intercommunication modem device via a satellite communication link.

10. A remote monitoring system for remotely monitoring a select aspect of an object, said system comprising:

(a) a remote intelligent communications device associated with said object, said remote intelligent communications device having:

(1) memory for storing data,

(2) a plurality of ports selectively enabled per associated control data, one of said plurality of ports being a primary RF interfacing port, and another of said plurality of ports being a secondary digital interfacing port, and

(3) a controller that receives command data for controlling various aspects of said remote communications device by way of configuration data;

(b) a monitoring control station for gathering data from said remote intelligent communication device, said monitoring control station having:

(1) a primary interfacing port, and

(2) a secondary interfacing port;

(c) an interrogator coupled to said primary interfacing port of said monitoring control station for enabling RF communication with said remote intelligent communications device via said primary RF interfacing port of said plurality of ports of said remote intelligent communications device; and

(d) a first modem device coupled to said secondary interfacing port of said monitoring control station for enabling selective alternative communications with said remote intelligent communications device, via said secondary digital interfacing port of said remote intelligent communications device.

11. A remote monitoring system according to claim 10, wherein said secondary digital interfacing port of said remote intelligent communications device comprises:

a second modem device in selective communication link with said first modem device for enabling communication between said monitoring control station and said remote intelligent communications device.

12. A remote monitoring system according to claim 11, wherein said secondary digital interfacing port includes an RS-232 interface between said secondary modem device and said remote intelligent communications device.

13. A remote monitoring system according to claim 11, wherein said first and second modem devices each comprise a wireless modem device for enabling communication therebetween via a wireless communication medium.

14. A remote monitoring system according to claim 11, wherein said first and second modem devices each comprise a cellular modem device for enabling communication therebetween via a cellular network.

15. A remote monitoring system according to claim 14, wherein said cellular modem devices include digital RF communication circuitry for enabling communication therebetween using a cellular digital packet communications format.

16. A remote monitoring system according to claim 11, wherein said first and second modem devices each comprise a satellite modem device for enabling communication therebetween via a satellite communications link.

17. A remote monitoring system according to claim 10, further comprising:

a transducer for generating a measurement signal proportional to the select aspect of said object;

wherein a given port of said plurality of ports of said remote intelligent communications device is coupled to receive the measurement signal from said transducer.

18. A remote monitoring system according to claim 17,

wherein said controller is selectively operative per appropriate command data to capture measurement data representative of said measurement signal for storage in said memory of said remote intelligent communications device; and

wherein said monitoring control station is configured to enable reading of data stored within said remote intelligent communications device via one of said primary interfacing port and said secondary interfacing port.

19. A remote monitoring system according to claim 17, wherein said transducer is a transducer from the group consisting of a pressure transducer, a temperature transducer, an acoustic transducer, a magnetic transducer, and an accelerometer, for monitoring respective attributes.

20. A remote monitoring system according to claim 17, further comprising:

a clock for providing time and date information;

wherein said remote intelligent communications device is configured to receive the time and date information from said clock, thereby enabling recording of the time and date information together with receipt of the measurement signal from said transducer.

21. A remote monitoring system according to claim 17, further comprising:

a global positioning system (GPS) receiver associated with said object for providing a coordinate signal in accordance with a geographic position of said object;

wherein another port of said plurality of ports of said remote intelligent communications device is coupled to receive the coordinate signal from said GPS receiver, thereby enabling logging of coordinate information of said object together with receipt of the measurement signal from said transducer.

22. A remote monitoring system according to claim 20, further comprising:

a clock for providing time and date information;

wherein said remote intelligent communications device is configured to receive the time and date information from the clock, thereby enabling recording of the time and date information together with logging of the coordinate information and receipt of the measurement signal from said transducer.

23. A remote monitoring system according to claim 17, further comprising:

an analog-to-digital (A/D) converter intermediate said transducer and said given port for converting an analog electrical signal of said transducer into a digital signal representative thereof as the measurement signal received by said given port.

24. A remote monitoring system according to claim 17, wherein said remote intelligent communications device further comprises an analog-to-digital converter for converting the measurement signal received at said given port into a digital signal representative thereof.

25. A remote monitoring system according to claim 24, wherein said analog-to-digital converter is selectively enabled by said controller in accordance with appropriate command data.

26. A remote monitoring system according to claim 17, wherein said remote intelligent communications device further comprises a comparator for comparing the measurement signal received at said given port to a predetermined threshold value, thereby enabling determination that the received measurement signal has moved beyond a predetermined threshold level.

27. A remote monitoring system according to claim 10, further comprising:

a global positioning system (GPS) receiver associated with said object for providing a coordinate signal in accordance with a geographic position of said object;

wherein a given port of said plurality of ports of said remote intelligent communications device is coupled to receive the coordinate signal from said GPS receiver, thereby enabling logging of coordinate information of said object in accordance with the received coordinate signal.

28. A remote monitoring system according to claim 27, further comprising:

a clock for providing time and date information;

wherein said remote intelligent communications device is configured to receive the time and date information from said clock, thereby enabling recording of the time and date information together with logging of the coordinate information.

29. A remote monitoring system according to claim 27, wherein said object comprises a truck, said truck having a "trip master"™ that obtains data regarding at least one parameter of said truck, said "trip master" having a digital port; and

wherein another port of said plurality of ports of said remote intelligent communications device is coupled to the digital port of said "trip master" for receiving data from said "trip master", enabling logging of trip master data together with the coordinate information.

30. A remote monitoring system according to claim 10, wherein said object comprises a truck, said truck having a "trip master" that obtains data regarding at least one parameter of said truck, said "trip master" having a digital port; and

wherein a given port of said plurality of ports of said remote intelligent communications device is coupled to the digital port of said "trip master" for receiving data from said "trip master".

31. A remote intelligent communications apparatus for remotely monitoring a pressure parameter, comprising:

(a) a remote intelligent communications device having:

a Radio Frequency (RF) communications port for communicating by way of an RF signal,

a demodulator for receiving and demodulating an RF input signal received at the RF communications port,

a controller that receives command data obtained selectively from the demodulated input signal, said controller controlling operation of the remote intelligent communications device in accordance with the received command data,

a monitoring port for receiving an external electrical signal,

memory for storing, as controlled by said controller, measurement data therein representative of the external electrical signal received at said monitoring port, and

a modulator for modulating an RF signal directed away from the RF communications port, the modulator providing modulation in accordance with select stored measurement data and selectively as controlled by said controller; and

(b) a pressure transducer coupled to said monitoring port of the remote intelligent communications device that generates an electrical signal in accordance with a pressure of an associated surrounding environment.

32. A remote intelligent communications apparatus according to claim 31,

wherein said pressure transducer generates an analog electrical signal; and

said apparatus further comprises an analog-to-digital converter for converting said analog electrical signal into digital data representative thereof.

33. A remote intelligent communications apparatus according to claim 31, wherein said pressure transducer generates an analog electrical signal; and

said apparatus further comprises a comparator for comparing said analog electrical signal to a given reference potential.

34. A remote intelligent communications apparatus according to claim 31, further comprising:

a clock for generating time and date information;

wherein said remote intelligent communications device is configurable, as controlled by said controller, to obtain and store time and date information of said clock in said memory, together with the measurement data.

35. A remote intelligent communications apparatus according to claim 31, further comprising:

a navigation receiver that provides navigation data in accordance with its geographic placement;

wherein the remote intelligent communications device further comprises a secondary interfacing port coupled to the navigation receiver for receiving navigation data; and

wherein said controller is operative, upon receiving appropriate command data, for enabling logging of said navigation data to be associated with measurement data stored in said memory.

36. A remote intelligent communications apparatus according to claim 35, wherein said navigation receiver comprises a GPS navigation receiver.

37. A remote intelligent communications apparatus according to claim 31,

wherein said RF communications port comprises an antenna structure for coupling an external electromagnetic transmission medium to electrical circuitry of the remote intelligent communications device; and

wherein said modulator includes a selective RF switching device cooperative with said antenna structure for altering matching/reflective characteristics of said antenna structure in accordance with said select stored measurement data.

38. A remote intelligent communications apparatus according to claim 37,

wherein said antenna structure includes a transmission line section having complimentary forward and return conductive paths; and

wherein said selective RF switching device comprises a device from the group consisting of a Schottky diode, a pin diode, a bipolar transistor, or a FET transistor, disposed functionally between said forward and return conductive paths, said device being selectively turned on/off in accordance with said select stored measurement data.

39. A remote intelligent communications apparatus according to claim 31,

wherein said RF communications port of the remote intelligent communications device comprises:

a receive antenna structure for receiving an RF input signal to be demodulated by the demodulator, and

a transmit antenna structure for transmitting an RF output signal of a given output carrier frequency;

wherein said remote intelligent communications device further comprises a synthesizer for providing a carrier signal of said given output carrier frequency; and

wherein said modulator of the remote intelligent communications device modulates said carrier signal in accordance with select stored measurement data and forwards the modulated carrier signal to the transmit antenna structure.

40. A remote intelligent communications apparatus for remotely monitoring an acceleration parameter, comprising:

(a) a remote intelligent communications device having:

a Radio Frequency (RF) communications port for external RF communications,

a demodulator for receiving and demodulating a RF input signal received at the RF communications port,

a controller that receives command data obtained selectively from the demodulated input signal, said controller controlling operation of the remote intelligent communications device in accordance with the received command data,

a monitoring port for receiving an external electrical signal,

memory for storing, as controlled by said controller, measurement data therein representative of the external electrical signal received at said monitoring port, and

a modulator for modulating an RF signal directed away from the RF communications port, the modulator providing modulation in accordance with select stored measurement data and selectively as controlled by said controller; and

(b) an accelerometer coupled to said monitoring port of the remote intelligent communications device that generates an electrical signal in accordance with acceleration thereof.

41. A remote intelligent communications apparatus according to claim 40,

wherein said accelerometer generates an analog electrical signal; and

said apparatus further comprises and analog-to-digital converter for converting said analog electrical signal into digital data representative thereof.

42. A remote intelligent communications apparatus according to claim 40,

wherein said accelerometer generates an analog electrical signal; and

said apparatus further comprises a comparator for comparing said analog electrical signal to a predetermined referenced potential.

43. A remote intelligent communications apparatus according to claim 40, further comprising:

a clock for generating time and date information;

wherein said remote intelligent communications device is configurable, as controlled by said controller, to obtain and store time and date information of said clock in said memory, together with the measurement data.

44. A remote intelligent communications apparatus according to claim 40, further comprising:

a navigation receiver that provides navigation data in accordance with its geographic placement;

wherein the remote intelligent communications device further comprises a secondary interfacing port coupled to the navigation receiver for receiving navigation data of the navigation receiver; and

wherein said controller is operative, upon receiving appropriate command data, for enabling logging of said navigation data to be associated with measurement data stored in said memory.

45. A remote intelligent communications apparatus according to claim 44, wherein said navigation receiver comprises a GPS navigation receiver.

46. A remote intelligent communications apparatus according to claim 40,

wherein said RF communications port comprises an antenna structure coupling an external electromagnetic transmission medium to electrical circuitry of the remote intelligent communications device; and

wherein said modulator includes a selective RF switching device cooperative with said antenna structure for altering matching/reflective characteristics of said antenna structure in accordance with said select stored measurement data.

47. A remote intelligent communications apparatus according to claim 46,

wherein said antenna structure includes a transmission line section having complimentary forward and return conductive paths; and

wherein said selective RF switching device comprises a device form the group consisting of a Schottky diode, a pin diode, a bipolar transistor, or a FET transistor, disposed functionally between said forward and return conductive paths, said device being selectively turned on/off in accordance with said select stored measurement data.

48. A remote intelligent communications apparatus according to claim 40,

wherein said RF communications port of the remote intelligent communications device comprises:

a receive antenna structure for receiving an RF input signal to be demodulated by the demodulator, and

a transmit antenna structure for transmitting an RF output signal of a given output carrier frequency;

wherein said remote intelligent communications device further comprises a synthesizer for providing a carrier signal of said given output carrier frequency; and

wherein said modulator of the remote intelligent communications device modulates the carrier signal in accordance with select stored measurement data and forwards the modulated carrier signal to the transmit antenna structure.

49. A method of remotely monitoring a pressure parameter, comprising steps:

(a) providing a remote intelligent communication device having:

an RF communication port for enabling external RF communications,

a controller for controlling operation of the remote intelligent communications device in accordance with command data, and

memory for storing, as controlled by said controller, measurement data;

(b) providing a pressure transducer that provides a measurement signal representative of a pressure of a surrounding environment;

(c) sending first command data to the remote intelligent communication device by way of said RF communications port for storing measurement data in said memory representative of a measurement signal of the pressure transducer; and

(d) sending second command data to the remote intelligent communications device by way of said RF communications port to enable reading and retrieval of measurement data stored in said memory.

50. A method according to claim 49, further comprising steps:

(e) retrieving said measurement data read from said memory of the remote intelligent communications device; and

(f) reporting information concerning pressure measured by said pressure transducer in accordance with the retrieved measurement data.

51. A method according to claim 50, further comprising:

repeating a plurality of times the steps (c) of sending the first command data, (d) of sending the second command data, and (e) of retrieving said measurement data.

52. A method according to claim 49, further comprising:

providing a navigation receiver coupled to the remote intelligent communications device that provides coordinate information representative of its geographic position;

wherein said step (c) of sending first command data includes provision of given command data for enabling logging, in said memory, as controlled by said controller, coordinate data representative of coordinate information provided by the navigation receiver.

53. A method according to claim 52, wherein said step (d) of sending the second command data includes provision of command data for also enabling reading and retrieval of coordinate data logged in said memory, said method further comprising:

retrieving said measurement data and said coordinate data as read from said memory of the remote intelligent communications device; and

reporting information concerning pressure measured by said pressure transducer in accordance with the retrieved measurement data together with coordinate information obtained by the navigation receiver in accordance with the retrieved coordinate data.

54. A method of remotely monitoring an acceleration parameter comprising:

(a) providing a remote intelligent communications device having:

a RF communications port for enabling external RF communications,

a controller for controlling operation of the remote intelligent communications device in accordance with command data, and

memory for storing, as controlled by said controller, measurement data;

(b) providing an accelerometer coupled to the remote intelligent communications device that provides a measurement signal representative of acceleration experienced by the accelerometer;

(c) sending first command data to the remote intelligent communications device by way of said RF communications port for storing measurement data in said memory representative of a measurement signal provided by the accelerometer; and

(d) sending second command data to the remote intelligent communications device by way of said RF communications port to enable reading and retrieval of measurement data stored in said memory.

55. A method according to claim 54, further comprising:

(e) retrieving said measurement data read from said memory of the remote intelligent communications device; and

(f) reporting information concerning acceleration measured by said accelerometer in accordance with the retrieved measurement data.

56. A method according to claim 55, further comprising:

repeating a plurality of times the steps (c) of sending the first command data, (d) of sending the second command data, and (e) of retrieving said measurement data.

57. A method according to claim 54, further comprising:

providing a navigation receiver coupled to the remote intelligent communications device that provides coordinate information representative of its geographic position;

wherein said step (c) of sending the first command data includes provision of given command data for enabling logging, in said memory, as controlled by said controller, coordinate data representative of coordinate information provided by the navigation receiver.

58. A method according to claim 57, wherein said step (d) of sending the second command data includes provisions of command data for also enabling reading and retrieval of coordinate data logged in said memory, said method further comprising:

retrieving said measurement data and said coordinate data as read from said memory of the remote intelligent communications device; and

reporting information concerning pressure measured by said pressure transducer in accordance with the retrieved measurement data together with coordinate information obtained by the navigation receiver in accordance with the retrieved coordinate data.

59. A remote monitoring apparatus comprising:

a radio frequency (RF) communications port;

a demodulator coupled to receive and demodulate a RF input signal forwarded from the RF communications port;

a controller that receives command data from the demodulator, said controller controlling various operations of the remote monitoring apparatus in accordance with the received command data;

memory for storing data therein, as controlled by said controller;

a modulator for modulating a RF signal directed away from the RF communications port, the modulator providing modulation in accordance with select stored data of said memory and selectively as controlled by said controller;

a transducer for measuring a given physical parameter and providing an associated measurement signal; and

a navigation receiver that provides navigation data in accordance with its geographic placemat;

wherein said controller is operative, per appropriate command data, to store in said memory measurement data representative of said measurement signal together with associated navigation data obtained by said navigation receiver.

60. A remote monitoring apparatus according to claim 59, further comprising:

a clock for providing time and date information;

wherein said controller is further operative, per appropriate command data, to store, in said memory, time and date information of said clock.

61. A remote monitoring apparatus according to claim 59,

wherein the navigation data of said navigation receiver includes coordinate data representative of its geographic placement along with time and date data; and

wherein said controller is operative, per appropriate command data, to store in said memory, both the coordinate data and the time and date data as said navigative data.

62. A remote monitoring apparatus according to claim 59, wherein said transducer provides said measurement signal in accordance with one of an electrical continuity, a pressure, a temperature, an acceleration, a light, or a magnetic field, as said given physical parameter.

63. A remote monitoring apparatus according to claim 59, further comprising:

a cargo bay having a movable door enabling selective passage into said cargo bay;

wherein said transducer is disposed proximate the door of said cargo bay for monitoring an open/close condition of the door and providing said measurement signed in accordance with the open/close condition.

64. A remote monitoring system comprising:

(a) a remote intelligent monitoring apparatus having

a responder communications port for enabling remote communications therewith;

data recovery circuitry for receiving an input signal from the communications port and recovering input data,

a controller that receives command data of the recovered input data and controls operations of the remote intelligent monitoring apparatus accordingly,

memory for storing data therein as controlled by said controller,

a transducer for measuring a given physical parameter and providing an associated measurement signed, and

a navigation receive that provides navigation data in accordance with its geographic placement,

wherein said controller is operative, per appropriate command data, to store in said memory measurement data representation of said measurement signal together with associated navigation data obtained by said navigation receiver; and

(b) a host control station having:

a host communications port enabling remote communications with the remote intelligent monitoring apparatus via its responder communications port,

host memory having therein a library of command data available for controlling the remote intelligent monitoring apparatus,

a host controller programmably operative to retrieve select command data of the library of command data from the host memory and send it out the host communications port for receipt by the remote intelligent monitoring apparatus, said host controller being further operative to send appropriate command data from the library of command data to the remote intelligent monitoring apparatus for enabling retrieval of stored measurement

data and navigation data from said memory of the remote intelligent monitoring apparatus, and

a host data processor for processing the retrieved measurement and navigation data, and providing respective report information regarding the given physical parameter and associated geographic placement in accordance with the retrieved measurement data and the retrieved navigation data.

65. A remote monitoring system according to claim 64, further comprising a display coupled to said host control station for displaying the report information provided by the host data processor.

66. A remote monitoring system according to claim 64, further comprising a clock for providing time and date information, thereby enabling recording and reporting of time and date information as part of said report information.

67. A remote monitoring apparatus according to claim 64, wherein said navigation receiver comprises a GPS navigation receiver.

68. A remote monitoring apparatus according to claim 64, wherein said transducer is a transducer for monitoring a physical parameter from the group consisting of an electrical continuity, a pressure, a temperature, an acceleration, a light, and magnetic field, as said given physical parameter.

69. A remote monitoring apparatus according to claim 64, wherein said transducer is disposed proximate a movable door of a cargo bay for monitoring an open/close condition of the door and providing an associated measurement signal representative thereof; and

wherein said host processor is operative to process the retrieved measurement data and navigation data, and correlate respective open/close door conditions with respective geographic placements as said report information in accordance with the retrieved measurement data and the retrieved navigation data.

70. A method of remote monitoring comprising:

providing a remote monitoring device having internal memory for storing data therein, as controlled by an internal controller;

providing a transducer for monitoring a given physical parameter, said transducer providing a measurement signal representative of the given physical parameter;

providing a navigation receiver for receiving navigation data;

configuring said remote monitoring device to store, within the internal memory, measurement data representative of said measurement signal of the transducer and navigation data of the navigation receiver; and

sending command data to the internal controller of the remote monitoring device to enable remote reading of measurement data and navigation data from the internal memory of said remote monitoring device.

71. A method according to claim 70 wherein said steps of configuring and sending comprise:

modulating an RF carrier signal with respective command data;

transmitting said modulated RF carrier signal to said remote monitoring device;

demodulating the received RF signal for recovering the respective command data; and

forwarding the recovered command data to the internal controller for configuring said remote monitoring device accordingly.

72. A method according to claim 70, further comprising:

reading stored data of said remote monitoring device said reading including modulating an RF signal directed away from said remote monitoring device in accordance with stored measurement data and stored navigation data obtained from said internal memory.

73. A method according to claim 71, wherein said transducer monitors an open/close condition of a door of a carrier cell and provides said measurement signal in accordance with said open/close condition; said method further comprising:

receiving the modulated RF output signal that was directed away from said remote monitoring device;

demodulating the received RF output signal and recovering the measurement data and the navigation data; and

correlating open/close conditions of the door of the carrier cell with associated geographic locations in accordance with the recovered measurement data and the recovered navigation data.

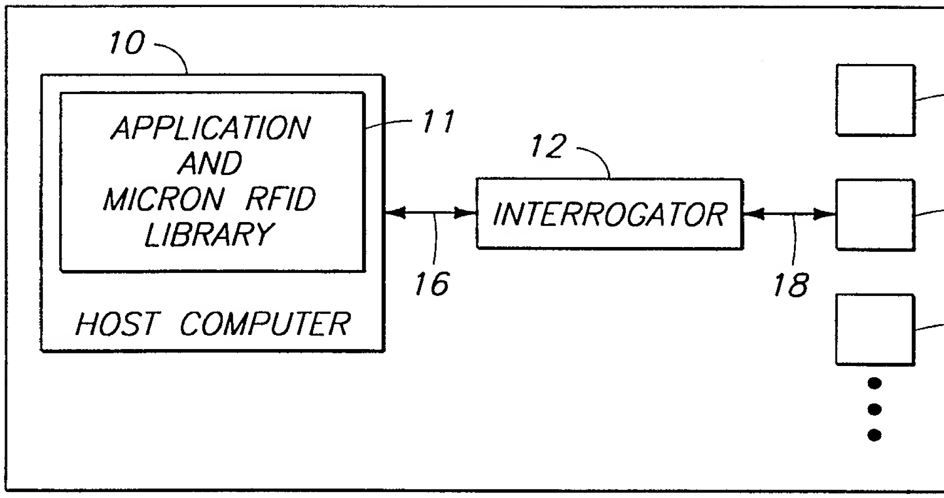
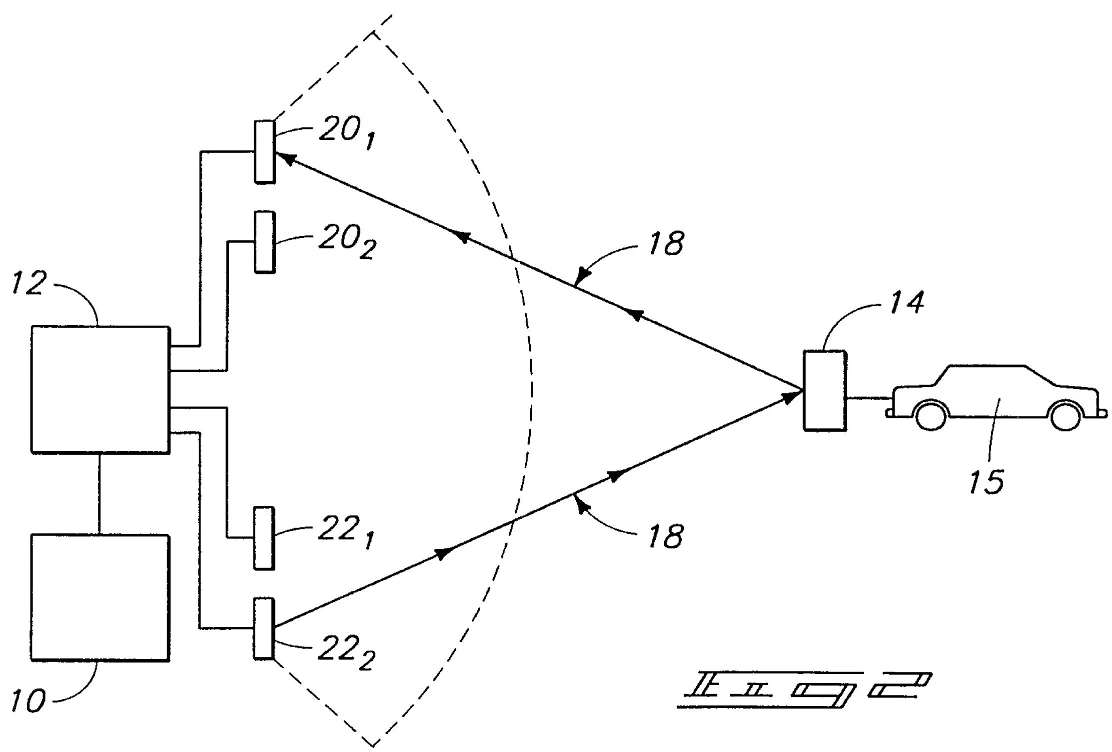

10
APPLICATION
AND
MICRON RFID
LIBRARY
11
HOST COMPUTER
12
INTERROGATOR
16
18
14_0
14_1
14_2

Fig 1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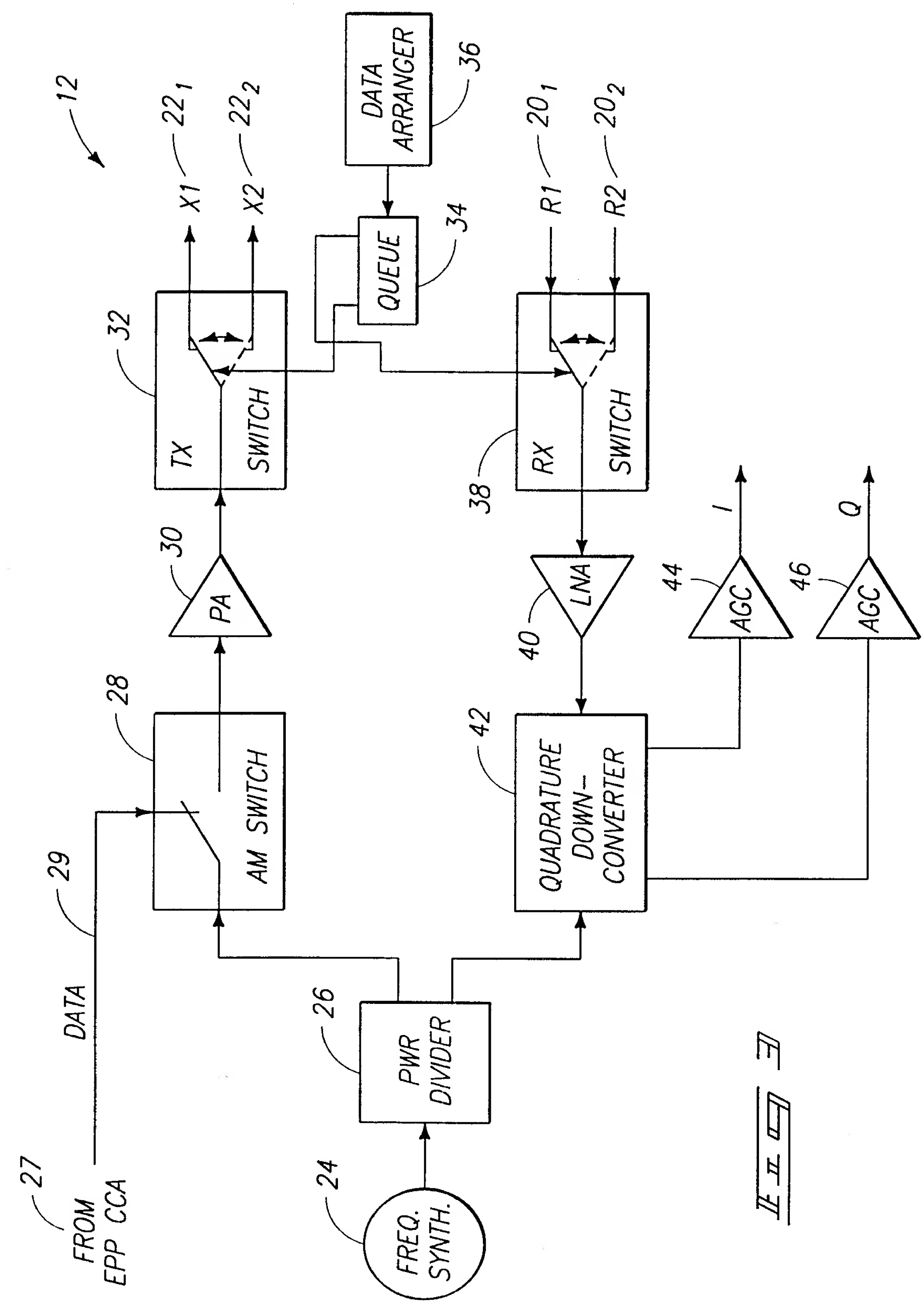
15

Fig 2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RX
SWITCH
38
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PA
LNA
40
44
AGC
I
46
AGC
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DATA
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PWR DIVIDER
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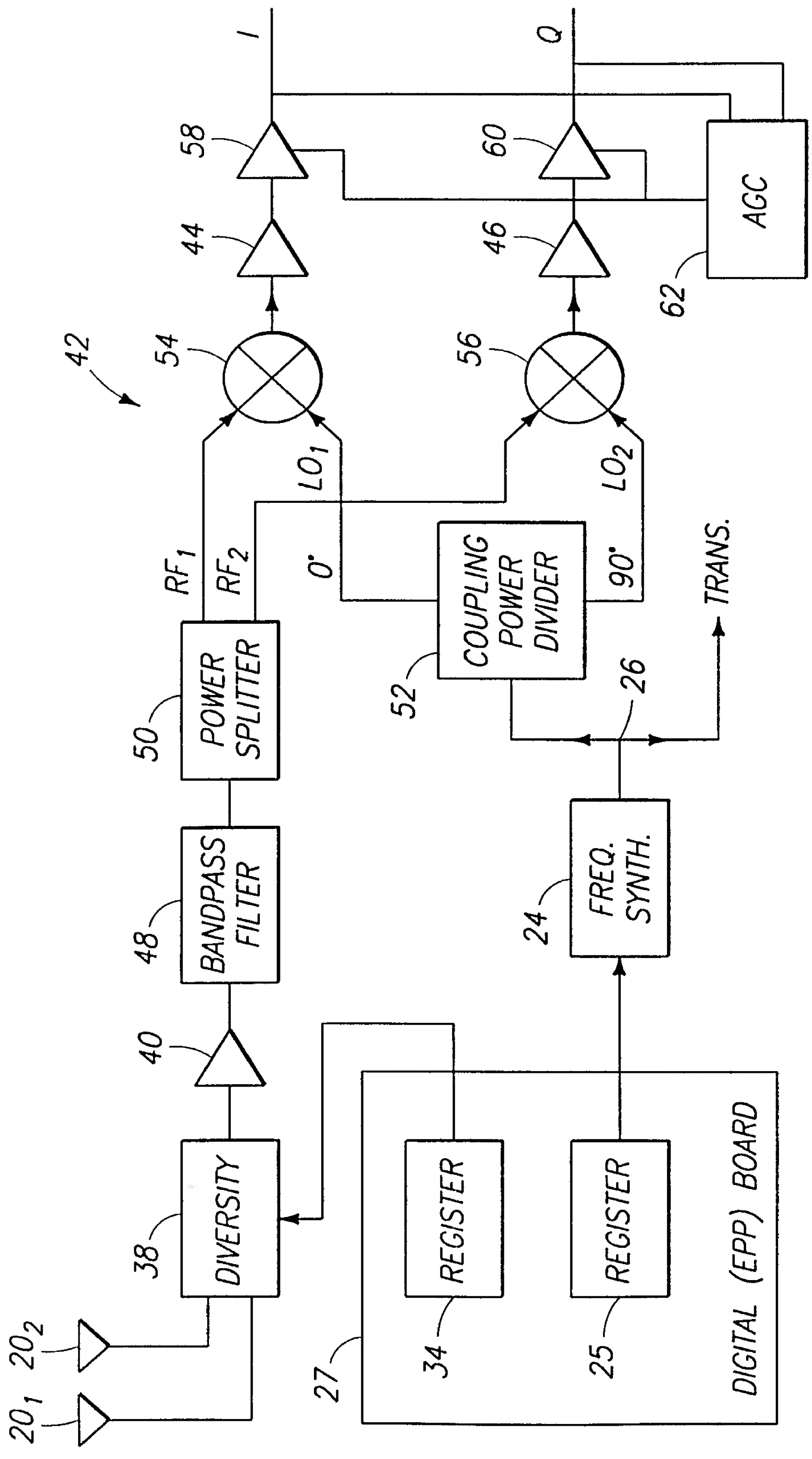
FREQ. SYNTH.
27
FROM EPP CCA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54
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LO2
RF1
RF2
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90°
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52
TRANS.
26
POWER SPLITTER
50
BANDPASS FILTER
48
FREQ. SYNTH.
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DIVERSITY
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REGISTER
34
REGISTER
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DIGITAL (EPP) BOARD
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20 2
20 1

Fig. 4

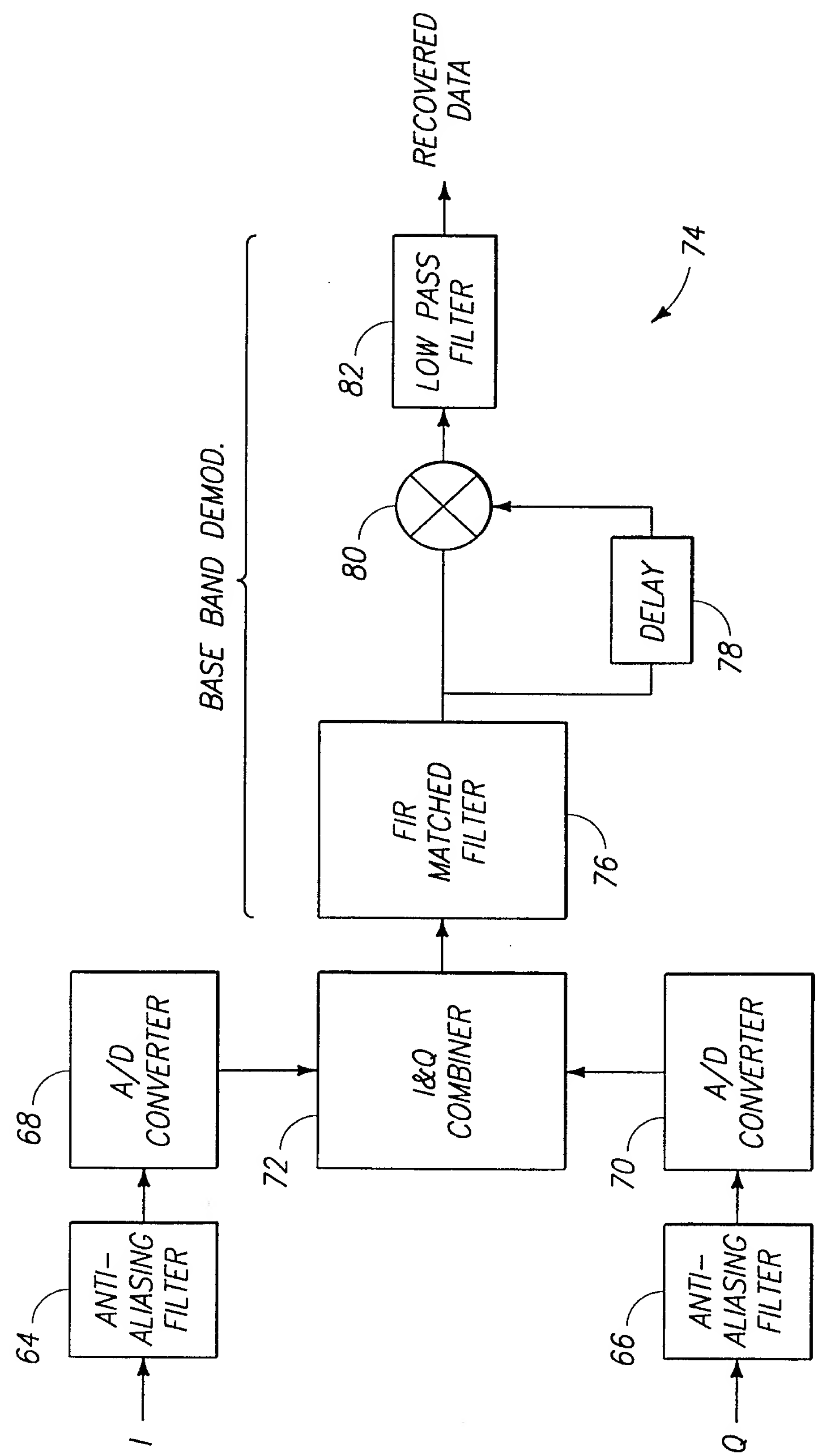
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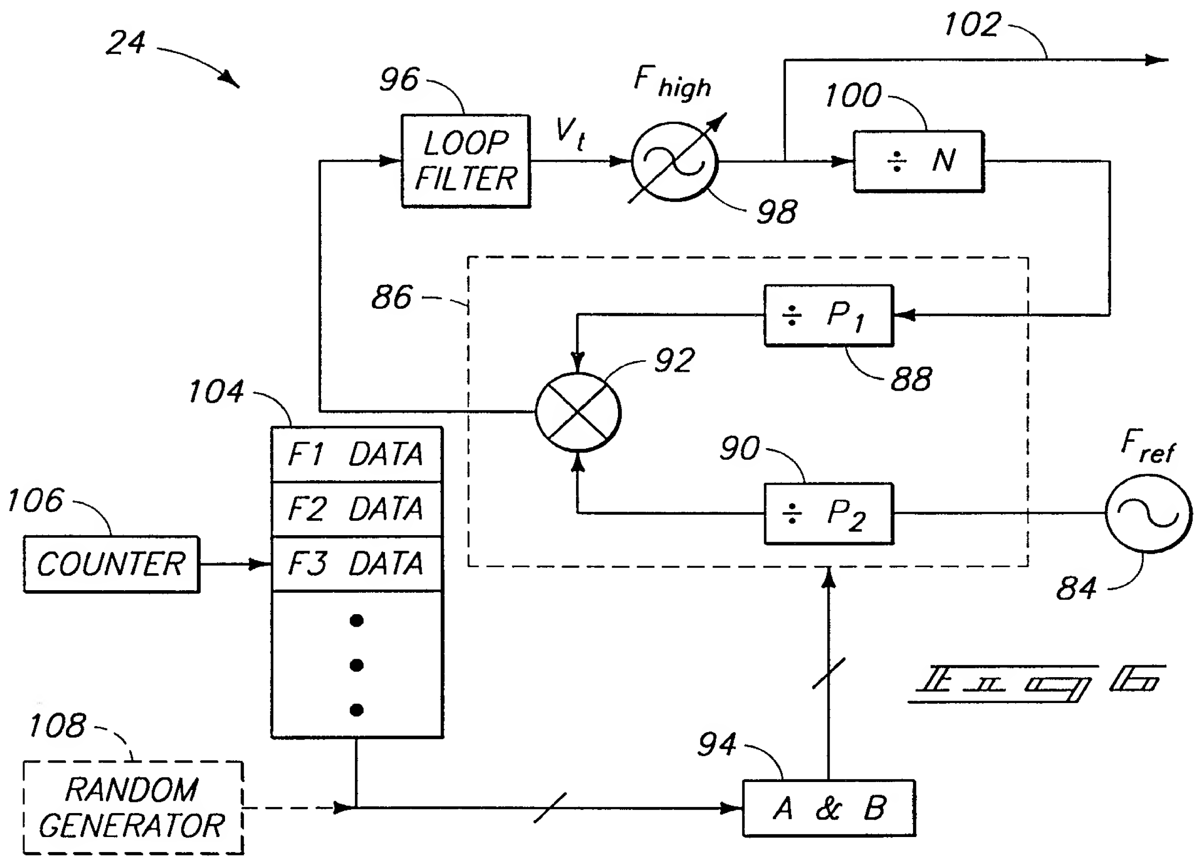
FIG. 5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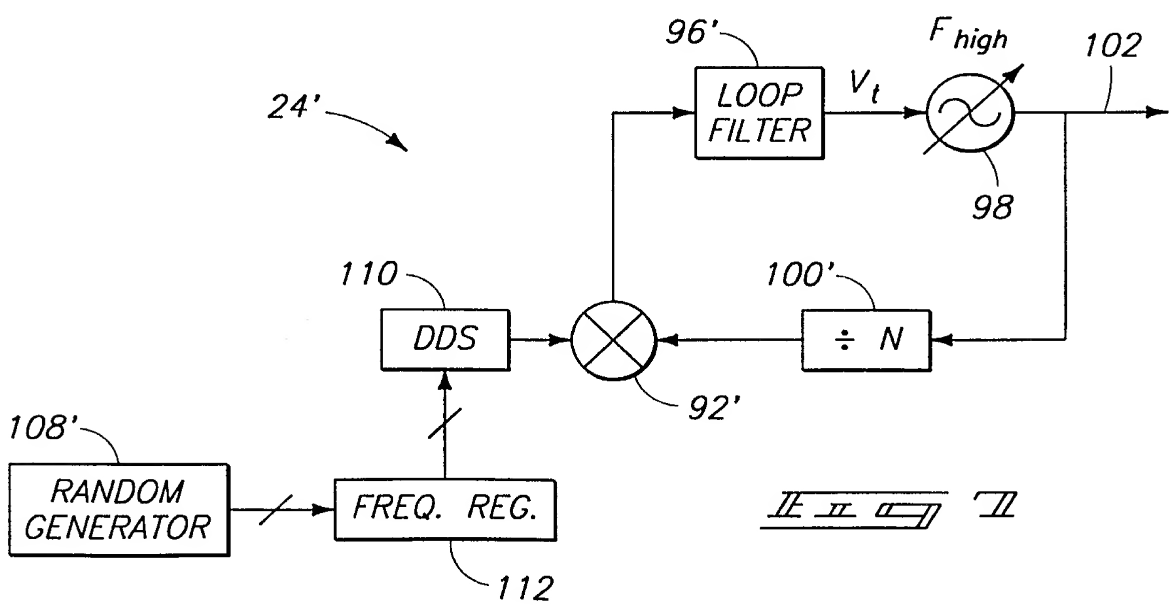
100
÷ N
86
÷ P_1
88
92
104
F1 DATA
F2 DATA
F3 DATA
106
COUNTER
90
÷ P_2
F_{ref}
84
108
RANDOM GENERATOR
94
A & B

Fig. 6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FREQ. REG.
112

Fig. 7